Remarks

Claims 1, 2 and 4-24 are pending in this application. Claims 3 and 25 have been canceled without prejudice and claims 1, 4, 11, 13, 14, 15, 23 and 24 are amended. Claim 11 was previously objected to due to a spelling error but has been amended correcting the spelling of "transmission." No new matter has been added as a result of the above amendments.

Rejection of claims 1-6, 14-17 and 25 are rejected under 35 USC 102(b)

Claims 1-6, 14-17 and 25 are rejected under 35 USC 102(b) as being anticipated by Yamada *et al.* (US 5,668,651). Applicant respectfully disagrees. It further should be noted that independent claims 1 and 14 have been amended to include the patentable features of claims 3 and 25, respectively, claim 3 and 25 having been canceled without prejudice.

The Examiner states, in Summary, that Yamada discloses a method for fabricating a liquid crystal display comprising providing a nematic liquid crystal and a photo-curable pre-polymer mixture, mixing the nematic liquid crystal with the photo-curable pre-polymer mixture to form a homogeneous nematic/pre-polymer mixture; providing a cell having a pair of spaced apart transparent substrates coated with a transparent conductive layer; filling the cell with the homogeneous mixture and photocuring the mixture using a spatially inhomogeneous illumination source. The Examiner fails to discuss the eutectic mixture of claims 3 and 25, now provided in independent claims 1 and 14.

Section 102 of Title 35 provides the novelty requirements for patentability. In order for a prior art reference to anticipate a claim it must teach each and every element of that claim. M.P.E.P. §2131. The Court of Appeals for the Federal Circuit states:"[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628 (CAFC, 1987).

The presently claimed invention (claims 1 and 14 being exemplary) provides a method of fabricating an optical device by providing a nematic liquid crystal formed from an eutectic mixture; providing a photo-curable pre-polymer mixture; mixing the nematic liquid crystal with the photo-curable pre-polymer mixture to form a homogeneous nematic/pre-polymer mixture, with the nematic liquid crystal representing greater than 40% (by weight) of the combined homogeneous mixture; and providing a cell including a pair of transparent substrates that are each coated with a transparent conductive layer when creating an electrooptic device and omitting the conductive layers when creating a static device. Further, in selected dependent claims the invention includes the steps of: separating the substrates by approximately 5-6 to about 8-20 μm; filling the cell with the homogeneous nematic/pre-polymer mixture; and photo-curing the nematic/pre-polymer mixture using a spatially inhomogeneous illumination source thereby forming a polymer dispersed liquid crystal (PDLC) film exhibiting low scattering loss and high index modulation.

There are significant distinctions between the art in Yamada (US 6,339,486) and the presently claimed invention. In order to better understand why Yamada fails to meet Applicant's claimed limitations, it is preferable to understand the distinct overall differences between Yamada and the present invention. For example, the nematic liquid crystal content in Yamada's displays is aligned via two mechanisms: (1) alignment layers (15 & 17 in Figs. 1A, B) on the substrates and (2) either an electric or magnetic field applied to the display during photo-curing the micrometer-scale bulk photo-polymer walls. In contrast, alignment is achieved in the present case via nanometer-scale photo-polymer walls only. Thus the material system in Applicant's claimed invention creates a polymer dispersed liquid crystal or PDLC, while the material in Yamada is not. Moreover, the photo-polymer content in Yamada contains photo-polymerizable nematics, while the photo-polymer content in the present invention does not due to the materials used. Further, light traversing Yamada's displays passes through bulk nematic layers only, while in the devices of the present invention, light passes through many photo-polymer/nematic interfaces (see Figs. 2c and 3 of the present application). Yamada's displays offer low contrast switching with relatively high scattering loss, while the

transmissive PDLC devices in the present invention as claimed, contrary to Yamada, achieve high contrast and low scattering loss.

The Examiner states "providing a nematic liquid crystal" is covered by Yamada 14:47-53 (column:lines). Yamada states chiral nematics or cholesteric LCs are preferred; however, the present invention prefers non-chiral nematics based on experimental data, in direct contrast with Yamada.

The Examiner further states, "wherein said nematic liquid crystal is a eutectic mixture" is covered by Yamada 14:66-67 and 18:24-25. To the contrary, when Yamada 14:46-67 expounds the preferred liquid crystal material for his displays, he does not even mention the word "eutectic" in his description. Further, it is clear from 14:49-51 and 14:51-52 that the preferred liquid crystals for Yamada's displays are either those with a finite concentration of negative dielectric anisotropy nematics or chiral (cholesteric or chiral nematic) liquid crystals. The presently claimed invention uses nematic liquid crystals being formed with eutectic mixtures, see amended claims 1 and 14. Eutectic mixtures are preferred in the present invention because they possess a wide temperature range of which they are in the nematic phase.

The Examiner also states "mixing said nematic liquid crystal with said photo-curable pre-polymer mixture to form a homogeneous nematic/pre-polymer mixture, with said nematic liquid crystal being greater than 40%(by weight) of said combined homogeneous mixture" is covered by Yamada 12:30-37 and 15:53-56. However, Yamada includes a polymerizable LC component in his mixtures; the polymerizable constituents in the present invention are not liquid crystalline. Further, Yamada utilizes an alignment layer to align the nematic content. Such an alignment layer would be detrimental for the present invention. Finally, Yamada cures his displays in an aligned state (aligned via the alignment layer); the gratings in the instant invention are orientationally isotropic prior to curing because no alignment layers are used.

The Examiner also states "filling said cell with said homogeneous nematic/pre-polymer mixture" is covered by Yamada 9:18-21. In actuality, Yamada "injects" the LC mixture into a cell that has substrates with an "orientation treatment." The devices of the presently claimed invention do not require any alignment treatment on the substrates.

The Examiner states "photo-curing said nematic/pre-polymer mixture using a spatially inhomogeneous illumination source thereby creating the electrooptic device in the form of a polymer dispersed liquid crystal (PDLC) exhibiting low scattering loss and high index modulation" is covered by Yamada 9:61-10:17 and 15:11-30. In actuality, Yamada uses spatially inhomogeneous UV radiation to "effect a photo-polymerization" at "a temperature equal to or higher than the homogenization temperature of the [polymer/liquid crystal] mixture," as described in 9:61-10:3. In contrast, the photo-polymerization process of the present invention does not take place at elevated temperature, in fact, under elevated temperatures the present invention would not work - for example, the gratings would be lost and drift would be experienced. Additionally, the present invention does not utilize an electric or magnetic field during photo-curing, as Yamada does by necessity, as stipulated in 9:18-27 and 9:46-52 and in method claims 9, 17, and 18. Further, Yamada describes the contrast of his displays in simple scalar terms in 15:11-30. As demonstrated by Applicant, a proper description of contrast for diffractive and non-dispersive PDLC optical devices requires a tensor approach. (See US Application 20020097355.)

The Examiner sets forth, "wherein said nematic liquid crystal possesses a positive dielectric anisotropy" is covered by Yamada 13:54-59. In contrast thereto, the Yamada reference to positive dielectric anisotropy nematic liquid crystals is actually referring to the liquid crystal polymerizable constituents in his mixtures – see 12:29-14:17. The present invention does not use polymerizable nematic material.

The Examiner further states, "wherein said substrates are separated by approximately 7 micrometers" is covered by Yamada 20:63-65. Actually, the modifier "approximately" doesn't appear in Yamada. To quote, "The substrates were attached to each other, and spacers having a particle size of 7 μm were injected ..." The invention as set forth in

claim 4 specifies the following, "The method as defined in claim 1 wherein said substrates are separated by approximately 5-20 μm." The claim as amended now claims substrates separated from about 5-6 μm to about 8-20 μm.

The Examiner recites "wherein said PDLC is comprised of a dispersion of discrete droplets containing nematic liquid crystal-rich material in a polymer-rich matrix" and "wherein said PDLC is comprised of inter-connected spaces that are filled with nematic liquid crystal-rich material" are covered by Yamada Figs. 1A and 1B. As pointed out above, Yamada's displays schematically depicted in his Figs. 1A and 1B are significantly different than the presently claimed invention's optical devices in several aspects. For example, Yamada uses alignment layers 15 and 17, the present invention does not; also, Yamada uses a polymerizable nematic in the polymer regions, the present invention does not; also, Yamada prefers chiral nematic, cholesteric, or negative dielectric anisotropy nematic constituents, while the clear preference in the instant invention are positive dielectric anisotropy nematics for the electro-active constituents; finally, Yamada uses bulk nematic liquid crystals, while the presently claimed invention employes PDLC materials.

The Examiner contends that claim 14 of the present invention – a claim covering static PDLC optical components – is covered by Popovich in US Patent 6,339,486B1, 17:52-18:10; however, Popovich describes static optical components that are not PDLC materials. In fact, the static components described in Popovich do not even contain nematic liquid crystals: an ingredient in the presently claimed invention's static devices.

Clearly, the "each and every element" rule articulated above has not been satisfied and therefore, the references cited by the Examiner fails to defeat novelty for the presently claimed invention. Therefore, Applicant respectfully requests reconsideration and withdrawal of the present rejection.

Furthermore, even if the Examiner relies upon a 35 USC 103 rejection of claims 1, 2, 4-6 and 14-17 in view of Yamada, such a rejection would be in error in view of the

many significant differences that exist between the presently claimed invention and that disclosed in Yamada.

Rejection of claims 7-9 and 18-20 under 35 USC 103(a)

Claims 7-9 and 18-20 are rejected under 35 USC 103(a) as being unpatentable over Yamada *et al.* (US 5,668,651) in view of Sumiyoshi *et al.* (US 6,278,506). Applicant respectfully disagrees.

The Examiner states that "Yamada *et al.* disclose a method of fabricating a liquid crystal device that is basically the same as that recited in claims 7-9 and 18-20 except for the step of deriving said spatially inhomogenous illumination source used to photo-cure the nematic/prepolymer mixture from the interference of two coherent optical beams within said cell." *Office Action, pg. 4, dated May 23, 2003.* The Examiner continues, "Sumiyoshi *et al.* disclose a method of fabricating a liquid crystal cell (Fig. 5A) comprising the step of deriving a spatially inhomogenous illumination source 16 used to photo-cure a nematic/pre-polymer mixture 15a ...

In order to establish a *prima facie* case of obviousness, "there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references) must teach or suggest all of the claim limitations." M.P.E.P. §2143, see also, *In re* Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Moreover, it is axiomatic in patent law that if an independent claim defines allowable subject matter then the claims depending therefrom also define allowable subject matter. *In re* Fine, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988), and Hartness International, Inc. v. Simplimatic Engineering Co., 819 F.2d 1100, 1108, 2 USPQ2d 1826, 1831 (Fed. Cir. 1987). Given that the rejected claims depend from base claims and those independent claims define allowable subject matter, then the claims at

issue must necessarily define allowable subject matter. The reasons for allowability of the base claims are set forth above.

The Examiner says "Thus, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the method of fabricating a LCD device of Yamada *et al.* with the teaching of Sumiyoshi *et al.* by employing two interfering optical beams which are incident symmetrically about a direction normal to said cell in order to form said PDLC as an unslanted PDLC transmission grating so as to produce a highly bright image for the display."

The assertion that the displays of Yamada could be made using two coherent interfering UV beams according to the teaching of Sumiyoshi is inaccurate. First, consider that Yamada never mentions the use of holographic fabrication techniques in his disclosure. This is not by oversight, but rather, by design and of necessity. Consider Yamada's exposition on the production method of his art in a lengthy section entitled "Production method," found in 9:10-10:17, specifically 9:28-38 where Yamada describes the UV radiation distribution as having "weakly irradiated regions" (quotes by Yamada) that he defines as those regions "not irradiated with UV-rays" (Yamada, 9:34-35). Thus, when Yamada says, "weakly irradiated," he by his own definition means <u>not</u> irradiated. Holographic irradiation distributions can never produce such idealized, sharp spatial features, but rather, smooth, sinusoidally-varying spatial distributions. Strictly speaking, a holographic exposure formed by the interference of two coherent optical beams does not allow for 2-dimensional regions with zero optical (UV) radiation, as required by Yamada. Yamada appreciated this and hence never allowed for holographic production methods in his invention.

Moreover, there is no teaching, suggestion, nor motivation provided by either reference to combine. Additionally, there is no evidence suggesting that were these two references combined the result would be Applicant's claimed invention. A case of *prima facie* obviousness has not been established and therefore Applicant respectfully requests reconsideration and withdrawal of the present rejection.

Rejection of claims 10-13 and 21-24 under 35 USC 103(a)

Claims 10-13 and 21-24 are rejected under 35 USC 103(a) as being unpatentable over Yamada *et al.* (US 5,668,651) in view of Sumiyoshi *et al.* (US 6,278,506) as applied to claims 7-9 and 18-20 and further in view of Popovich *et al.* (US 6,339,486). Applicant respectfully disagrees.

The combination of Yamada with Sumiyoshi has been argued above and applies equally here. Additionally, the Applicant again asserts that if a base claim defines allowable subject matter, then claims depending therefrom also define allowable subject matter. Given that the rejected claims depend from base claims and those independent claims define allowable subject matter, then the claims at issue must necessarily must define allowable subject matter.

The Examiner further states "Thus, it would have been obvious to one having ordinary skill in the art at the time the invention was made to further modify the device of Yamada *et al.* with the teaching of Popovich *et al.* by forming the unslanted PDLC transmission grating with a grating period that is greater than half the wavelength of the light to be diffracted by the PDLC transmission grating during use of said transmission grating or a spatial frequency that is sufficiently high to prohibit propagating diffracted orders for normal incident light, thereby creating an electrooptic retarder with electrically tunable birefringence or a retarder so as to improve the display brightness."

The assertion that the devices of Yamada could be "modified" and used as low-loss, high contrast, high-switching-speed gratings or retarders by applying the teaching of Popovich is highly speculative and inaccurate. It is important to recognize that the morphology in Yamada's devices is based on nematic liquid crystal confined to roughly cylindrical-shaped volumes typically 10,000 μm^3 ($= \Pi r^2 \bullet h$ where $r \sim 25$ μm is the pixel radius and $h \sim 5$ μm is the pixel, or cell, height). In contrast, the PDLC devices of the presently claimed invention have nematic confined to roughly spherical-shaped volumes that are on the order of 0.5 μm^3 ($=4\Pi r^3/3$ where $r \sim 0.5$ μm is the nematic droplet radius).

The ratio of the nematic confinement volume in Yamada's devices to the instantly claimed invention's devices is thus 18,750:1. The assertion that Yamada's devices could be modified to function similarly to the presently claimed invention implies Yamada could shrink the size of the confined nematic regions from r ~ 25 μm, h ~ 5 μm to r ~ 0.18 μm, h ~ 5 μm to achieve the same nematic confinement volumes as in the instantly claimed invention's devices, while still maintaining the nematic bend orientation that is essential to the displays of Yamada (see, for example, Yamada's abstract, Figs. 1A, B, claims 1-17 *etc.*).

In light of the vast physical size difference of the morphological features in the materials utilized by Yamada and the presently claimed invention, Applicant respectfully submits that the technologies described in the presently claimed invention is not merely a modification of Yamada. Further, no direct comparisons of function or performance can be made between Yamada and the instant invention by virtue of the fact that Yamada describes bulk nematic liquid crystal displays, while the present invention describes polymer-confined nematic devices (primarily beam-steering and polarization-rotating switches).

There again is no suggestion, teaching or motivation to combine the references cited by the Examiner. Additionally, there is no evidence suggesting that were these references combined the result would be Applicant's claimed invention. A case of *prima facie* has not been established and therefore the Applicant respectfully requests reconsideration and withdrawal of the present rejection.

In conclusion, in view of the above amendments and remarks, Applicant respectfully requests the Examiner find claims 1, 2 and 4-24 allowable over the prior art and issue a Notice of Allowance.

Although no fees are required, please charge any underpayment of fees to or credit any overpayment of fees to Deposit Account No. 50-1078.

The Examiner is invited to call the undersigned attorney at (617) 854-4281 should he determine that a telephonic interview would expedite prosecution of this case.

Respectfully submitted,

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